



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : B01D 17/038	A1	(11) International Publication Number: WO 92/18216 (43) International Publication Date: - 29 October 1992 (29.10.92)
<p>(21) International Application Number: PCT/NO92/00065</p> <p>(22) International Filing Date: 8 April 1992 (08.04.92)</p> <p>(30) Priority data: 911425 11 April 1991 (11.04.91) NO</p> <p>(71)(72) Applicant and Inventor: HEGGERTVEIT, Fredrik [NO/NO]; Oscar Hansens vei 7, N-6400 Molde (NO).</p> <p>(74) Agent: COWARD, Bjarne, Gorgus; Bryns Patentkontor A/S, P.O. Box 9566, Egertorget, N-0128 Oslo (NO).</p> <p>(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US.</p>		<p>Published <i>With international search report.</i></p>
<p>(54) Title: SEPARATOR FOR AT LEAST TWO SUBSTANCES HAVING DIFFERENT DENSITIES, AT LEAST ONE OF WHICH IS A LIQUID</p> <p>(57) Abstract</p> <p>A liquid separator for separation of a mixture of at least two substances having different densities, at least one of which substance is a liquid, comprising a preferably cylindrical housing (7) having a tangential inlet (2) at the upper end and an outlet (12) at the lower end thereof, that there are centrally disposed within the housing a plurality of vertically spaced plate members (3) having the form of a truncated cone with the open vertex oriented upward, and that the vertex (4) of the uppermost plate member is connected to a transport line (5). The housing (7) has between the inlet (2) and outlet (12) thereof at least one annular expanded area (9) provided with one or more current generators (13).</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	RU	Russian Federation
CG	Congo	KP	Democratic People's Republic of Korea	SD	Sudan
CH	Switzerland	KR	Republic of Korea	SE	Sweden
CI	Côte d'Ivoire	LI	Liechtenstein	SN	Senegal
CM	Cameroon	LK	Sri Lanka	SU	Soviet Union
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
DE	Germany	MC	Monaco	TC	Togo
DK	Denmark			US	United States of America

SEPARATOR FOR AT LEAST TWO SUBSTANCES HAVING DIFFERENT DENSITIES, AT LEAST ONE OF WHICH IS A LIQUID.

5

The present invention relates to a liquid separator and particularly a separator for separating a liquid having low density from water. It is not limited to liquids only, as it will also separate out substances and particles that have low

10

In connection with increased oil extraction offshore, and increasing transport of oil by ship, there is a steadily growing risk of oil spills into the water. To collect up oil from water, the oil must first be concentrated and confined, and this is normally done with the aid of oil booms. Then, known equipment such as skimmers, mops, etc., is used to transport oil mixed with water from this enclosure to the collection site. The mixture may then be subjected to further separation as required, in accordance with several known methods. There exist a number of separator systems with a high degree of efficiency for oil/water of both high and low concentrations. Several of the systems, which are sensitive with regard to solid matter, are based on high technology, are costly, and are poorly suited for the first phase of separation of oil from water in major oil spills. The present invention is based on new principles, is robust and is not particularly vulnerable to solid matter. It would be capable of separating oil from water in both large and small concentrations, and is therefore not dependent on oil booms for concentrating the oil prior to collection. The separator may placed conveniently in ships which draw in large amounts of water mixed with oil without major preparation as with use of booms, skimmers, etc.

35

The purpose of the present invention is to provide a separator having excellent separation properties for two or

more substances of different densities, at least one of which is a liquid, where the concentration of one of the liquids is very small, for example, in cases of major oil spills at sea.

5 This is achieved with a separation assembly according to the invention consisting of a preferably cylindrical housing having a tangential inlet at the upper end and an outlet at the lower end thereof, where there are centrally disposed within the housing a plurality of vertically spaced plate
10 members in the form of a truncated cone with the open vertex oriented upward; the uppermost plate member being connected to a transport line for the liquid having lowest density. The invention is also characterized in that the housing is provided, between the inlet and the outlet thereof, with at
15 least one annular expanded area provided with one or more current generators.

A preferred embodiment form of the invention will now be described in more detail with reference to the accompanying
20 drawings.

Fig. 1 shows a vertical section through a separator in accordance with the invention, seen from the side.

25 Fig. shows a horizontal section through the separator along line A-A in Fig. 1.

Fig. 3 shows a horizontal section through the separator along line B-B in Fig. 1.

30 Fig. 4 shows a horizontal section through the separator along line C-C in Fig. 1.

35 Figure 1 shows a section through the separator consisting of a top plate 2, a cylinder 7, which is encircled by a larger annular channel 9 and the bottom 12. In the center of the separator are mounted a plurality of truncated conical plates

3, which expediently are fastened to the main structure of the separator. The diameter of the conical plates 3 is somewhat smaller than the interior diameter of cylinder 7. Within the annular channel 9 is mounted a current generator 13 (shown here as a propeller), which is driven by motor 15. The channel 9 is additionally provided with suitable current stabilizers 14, according to need.

The mixture, preferably oil and water, enters tangentially at the top of the separator at 1 so as to be set into rotation within the separator's cylinder 7. The mixture then flows down along the walls of cylinder 7. Due to the action of centrifugal force on the mixture as a consequence of the rotation, the liquid having lowest density (oil) will be drawn in toward the center of cylinder 7, while the liquid having greatest density (water) will be cast out toward the walls of cylinder 7. The velocity of the mixture will decline toward the center of the cylinder, so that when the oil particles are drawn inward and come under the edge of a cone 3, the rate of rotation will be further decreased due to the friction against the cone, at the same time as the oil particles will have a better opportunity to float upward. When an oil particle has entered the area beneath cone 3, there are no forces to draw it outward again, and the oil is trapped. The oil particles float upward and collect underneath the uppermost cone 4, wherefrom the oil 6 is pumped out of the separator via transport line 5.

The separation takes place continuously, whilst the mixture sinks down through the separator toward the outlet 11. The current generator driven by motor 15 accelerates the mixture when it arrives at channel 9. This substantially increases the separation effect. Acceleration channel 9 is an expedient feature for two reasons. It reduces the need to have a very high separator for treatment of a specific mixture in order to achieve satisfactory separation; it cuts down the required separation height by virtue of the increasing velocity.

Motor 15 may have a varying speed, thereby enabling the regulation of the acceleration of the mixture. This is an essential feature of the invention, as it makes possible the adaptation of the separation effect both in accordance with the amount of mixture introduced into the separator, and in situations where it is difficult to achieve a satisfactory separation.

Although the present invention is described with reference to a specific embodiment form, it is self-evident that a person skilled in the art may make changes and modifications without deviating from the scope of protection for the invention. Such modifications may entail, for example, substantially changing the length 3 of the cylinder, or utilizing more or fewer acceleration channels 9. There may also be used other types of current generators than the one that is shown here.

20

25

30

35

P a t e n t C l a i m s

1.

5 A separator assembly for a mixture of at least two substances having different densities, at least one of which substance is a liquid, which assembly comprises a preferably cylindrical housing (7) having an outlet (12) at the lower end thereof, a plurality of vertically spaced plate members (3)
10 having the form of a truncated cone with the open vertex oriented upward, and wherein the vertex (4) of the uppermost member is connected to a transport line (5),
c h a r a c t e r i z e d i n . that the inlet (2) in the upper end is placed tangentially.

15

2.

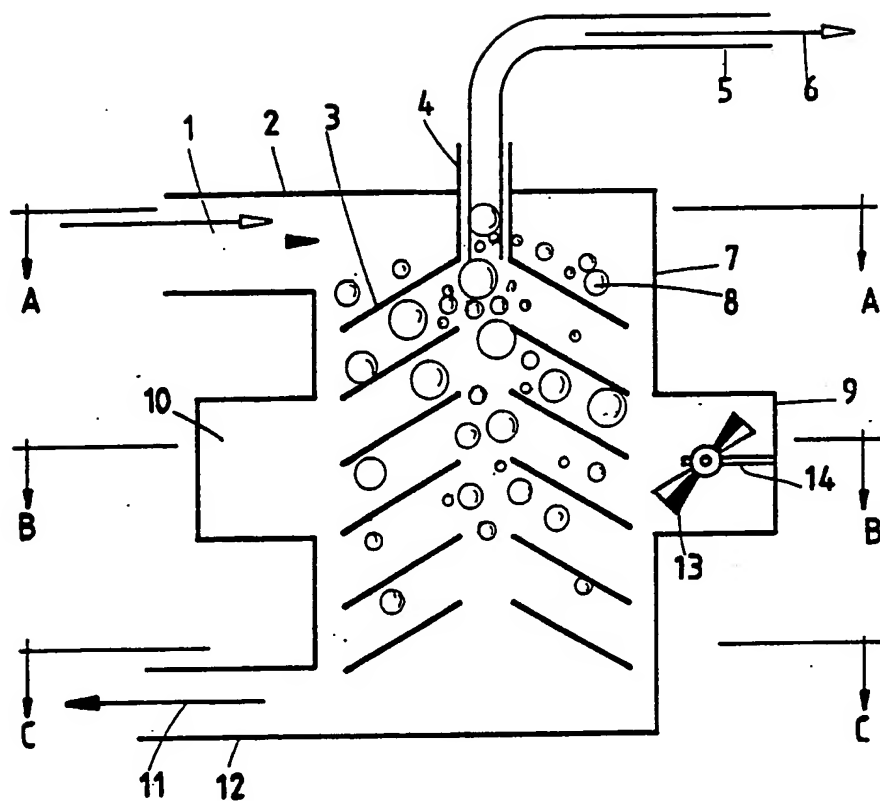
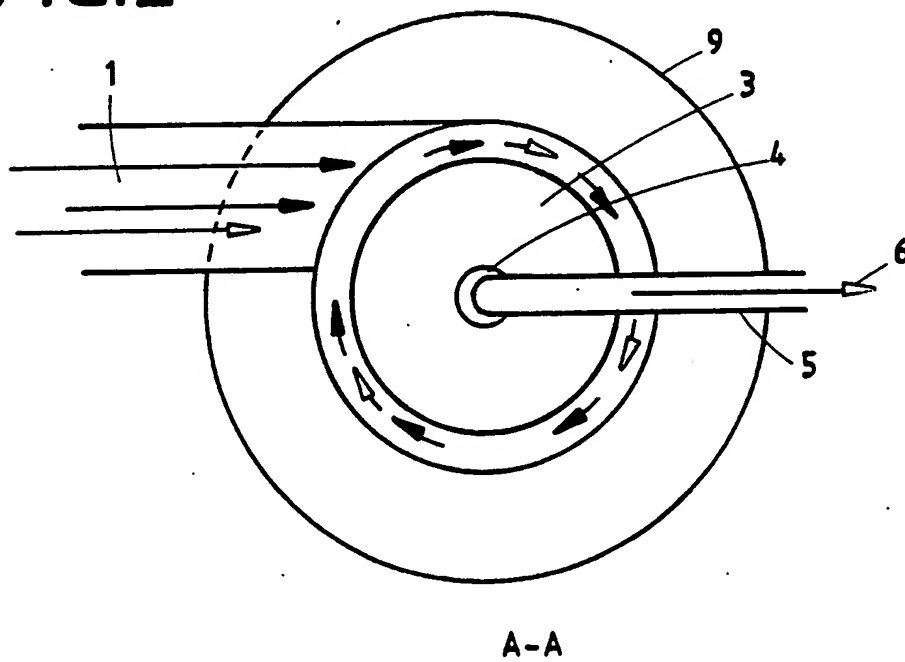
The assembly according to claim 1, c h a r a c t e r i z e d
i n that the housing (7) between the inlet (2) and outlet (12) has at least one annular expanded area (9) provided with
20 one or more current generators (13).

25

30

35

1/2

FIG.1**FIG.2**

2/2

FIG.3

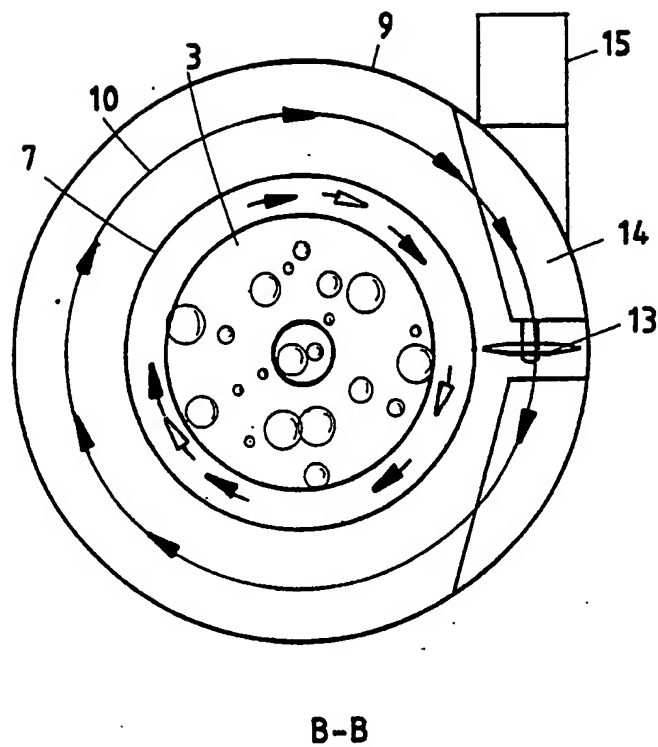
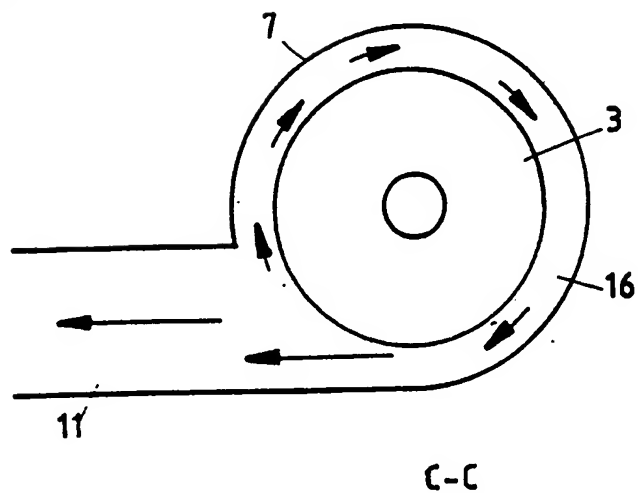


FIG.4



INTERNATIONAL SEARCH REPORT

International Application No PCT/NO 92/00065

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: B 01 D 17/038																	
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">IPC5</td> <td style="padding: 5px;">B 01 D</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div> <p style="padding: 5px;">SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	B 01 D											
Classification System	Classification Symbols																
IPC5	B 01 D																
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; padding: 5px;">Category *</th> <th style="width: 60%; padding: 5px;">Citation of Document,¹¹ with Indication, where appropriate, of the relevant passages¹²</th> <th style="width: 30%; padding: 5px;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">DE, A1, 2507190 (BOLL & KIRCH FILTERBAU GMBH) 2 September 1976, see figure 1; claim 1 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">SE, C, 116439 (AKTIEBOLAGET SEPARATOR) 28 May 1946, see figure 1 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">DE, C2, 2453555 (SOCIÉTÉ GÉNÉRALE DE CONSTRUCTIONS ELECTRIQUES ET MÉCANIQUES ET AL) 17 February 1983, see figure 1 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">2</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US, A, 1709971 (HARRISON S. COE) 23 April 1929, see figure 3 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> </tbody> </table>			Category *	Citation of Document, ¹¹ with Indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	Y	DE, A1, 2507190 (BOLL & KIRCH FILTERBAU GMBH) 2 September 1976, see figure 1; claim 1 --	1	Y	SE, C, 116439 (AKTIEBOLAGET SEPARATOR) 28 May 1946, see figure 1 --	1	A	DE, C2, 2453555 (SOCIÉTÉ GÉNÉRALE DE CONSTRUCTIONS ELECTRIQUES ET MÉCANIQUES ET AL) 17 February 1983, see figure 1 --	2	A	US, A, 1709971 (HARRISON S. COE) 23 April 1929, see figure 3 --	1
Category *	Citation of Document, ¹¹ with Indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³															
Y	DE, A1, 2507190 (BOLL & KIRCH FILTERBAU GMBH) 2 September 1976, see figure 1; claim 1 --	1															
Y	SE, C, 116439 (AKTIEBOLAGET SEPARATOR) 28 May 1946, see figure 1 --	1															
A	DE, C2, 2453555 (SOCIÉTÉ GÉNÉRALE DE CONSTRUCTIONS ELECTRIQUES ET MÉCANIQUES ET AL) 17 February 1983, see figure 1 --	2															
A	US, A, 1709971 (HARRISON S. COE) 23 April 1929, see figure 3 --	1															
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>* Special categories of cited documents:¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>																	
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px; vertical-align: top;"> Date of the Actual Completion of the International Search 15th July 1992 </td> <td style="width: 50%; padding: 5px; vertical-align: top;"> Date of Mailing of this International Search Report 1992 -07- 20 </td> </tr> <tr> <td style="width: 50%; padding: 5px; vertical-align: top;"> International Searching Authority <div style="text-align: center;">SWEDISH PATENT OFFICE</div> </td> <td style="width: 50%; padding: 5px; vertical-align: top;"> Signature of Authorized Officer Bo Bergström </td> </tr> </table>			Date of the Actual Completion of the International Search 15th July 1992	Date of Mailing of this International Search Report 1992 -07- 20	International Searching Authority <div style="text-align: center;">SWEDISH PATENT OFFICE</div>	Signature of Authorized Officer Bo Bergström											
Date of the Actual Completion of the International Search 15th July 1992	Date of Mailing of this International Search Report 1992 -07- 20																
International Searching Authority <div style="text-align: center;">SWEDISH PATENT OFFICE</div>	Signature of Authorized Officer Bo Bergström																

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	Derwent's abstract, No. 84- 73 001/12, SU 1 018 680, publ. week 8412 -----	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/NO 92/00065**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 29/05/92. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 2507190	76-09-02	NONE	
SE-C- 116439	46-05-28	NONE	
DE-C2- 2453555	83-02-17	BE-A- 821371	75-04-23
		CA-A- 1046949	79-01-23
		CH-A- 584051	77-01-31
		FR-A-B- 2250557	75-06-06
		GB-A- 1475760	77-06-10
		JP-C- 1092969	82-04-16
		JP-A- 50083859	75-07-07
		JP-B- 56036962	81-08-27
		NL-A- 7414634	75-05-16
		OA-A- 4840	80-10-31
		US-A- 3915858	75-10-28
US-A- 1709971	29-04-23	NONE	